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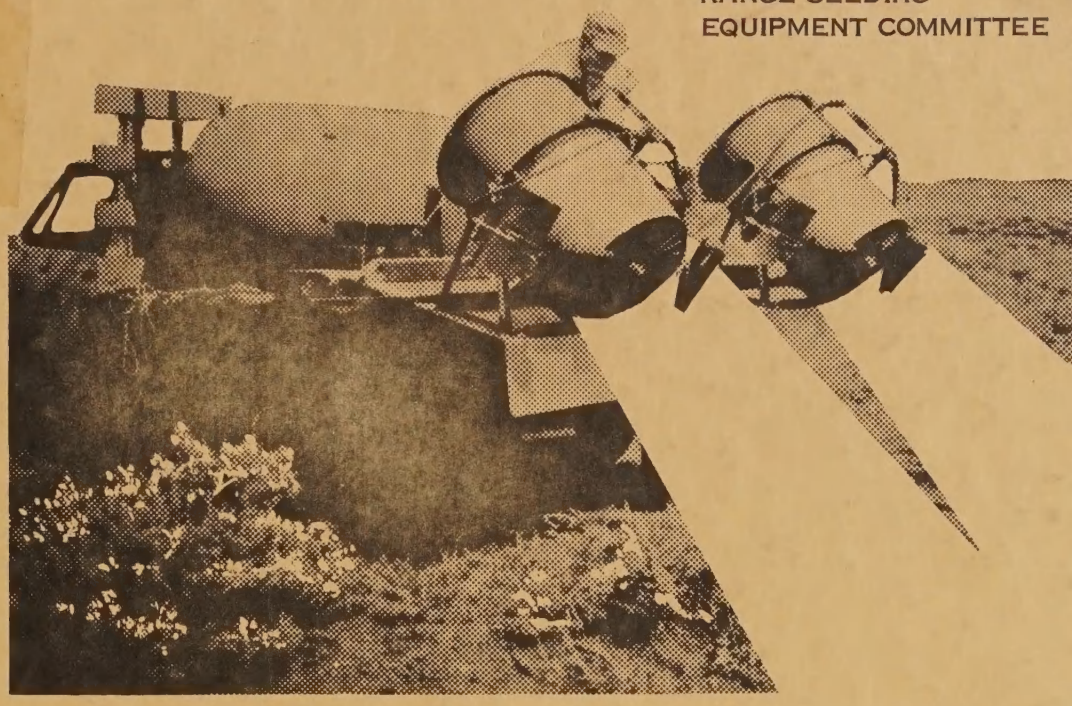
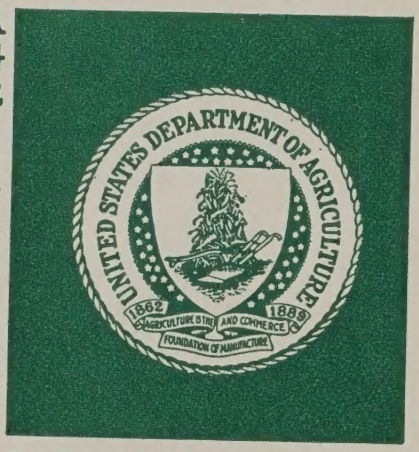


THERMAL BRUSH CONTROL

ED&T 2168

FEBRUARY 1973

U.S. Department of Agriculture
Forest Service
Equipment Development Center
Missoula, Montana



ED&T 2168

THERMAL BRUSH CONTROL

By

ALBERT V. BELLUSCI.

MECHANICAL ENGINEER

February 1973

USDA Forest Service
Equipment Development Center
Missoula, Montana

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ABSTRACT

Two types of thermal prototype equipment were fabricated and evaluated for treatment of large areas of sagebrush. One was identified as the low volume-high velocity model and the other as the high volume-low velocity model.

Operational field tests of the more productive (high volume-low velocity) equipment were conducted on three plots totaling 26 acres. The maximum rate of treatment by the equipment has not been determined to date. Cost of treatment for individual plots was as low as $5.20 per acre for fuel (@ 20¢ per gallon) and a treatment rate of 3.3 acres per hour. Average cost of treatment for the three plots was $7.20 per acre for fuel (@ 20¢ per gallon) and an average treatment rate of 2.3 acres per hour.

An improved model has been completed and will be evaluated during FY 1973 and FY 1974. This model is designed for mounting on more versatile vehicles, will have double the treatment width (from 10-11 feet to 20-22 feet) and will have provisions for adjusting equipment elevation, air-volume, velocity, direction and temperature within specific limits.

INTRODUCTION

Project ED&T 2168, an investigation into the effects of heat on sagebrush, was initiated under the title of Brush Burner. Under this investigation, two methods of brush control equipment were evaluated. These were (1) agricultural burning equipment of the type previously used for sagebrush control and (2) a new concept of plant control equipment with a capability of high heat release below the ignition temperature of plants (fig. 1).

After observing plants for more than a year that were treated with this new equipment, it has been established that sagebrush can be controlled by this method.

Under the continued project of ED&T 2168 (the project title changed to Thermal Brush Control), new concepts were incorporated in the design for the purpose of developing more useful and practical equipment for field use of plant control. This report includes the developments and evaluations of control equipment and methods.

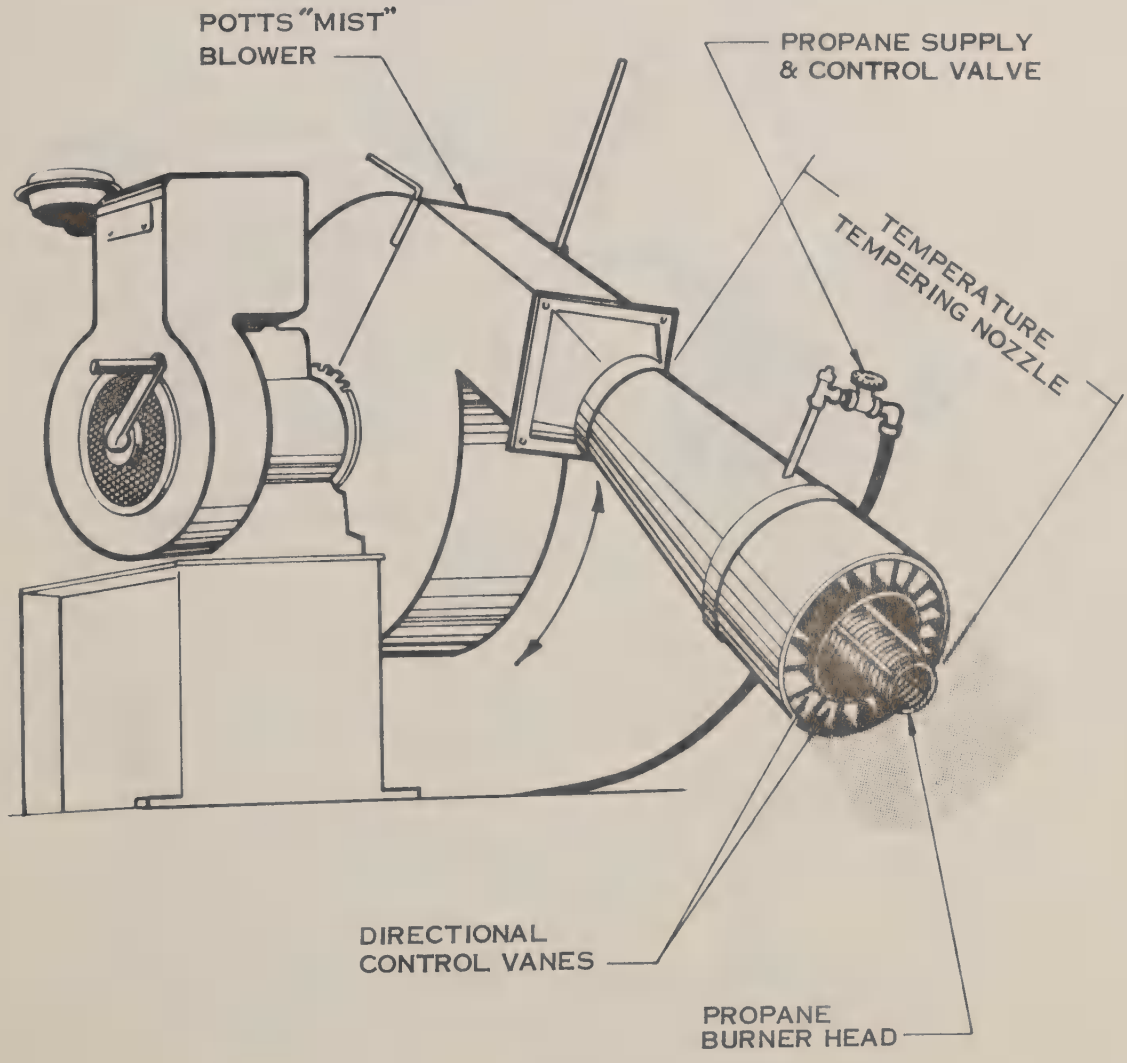


Figure 1.--Plant control concept (high heat release).

Design Concepts for Prototype Equipment

Two types of prototype equipment were fabricated to evaluate their respective effectiveness in treating sagebrush acreage.

1. A modification in the original test device was made to increase air volume, velocity and temperature. This modification was made for the purpose of providing an airstream, of known conditions, that, when mounted to discharge from the side of moving vehicle, would expose the airstream to a wide strip of plants. This equipment was identified as low volume-high velocity (fig. 2).

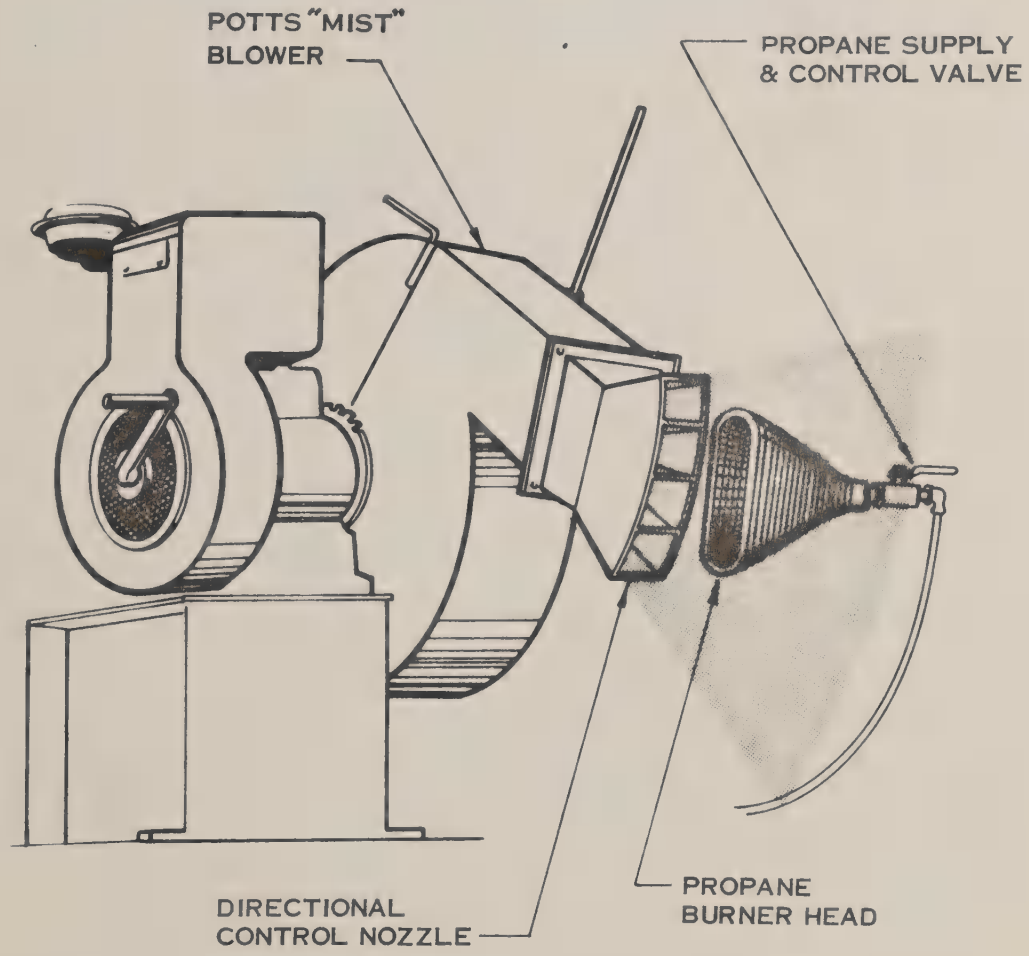
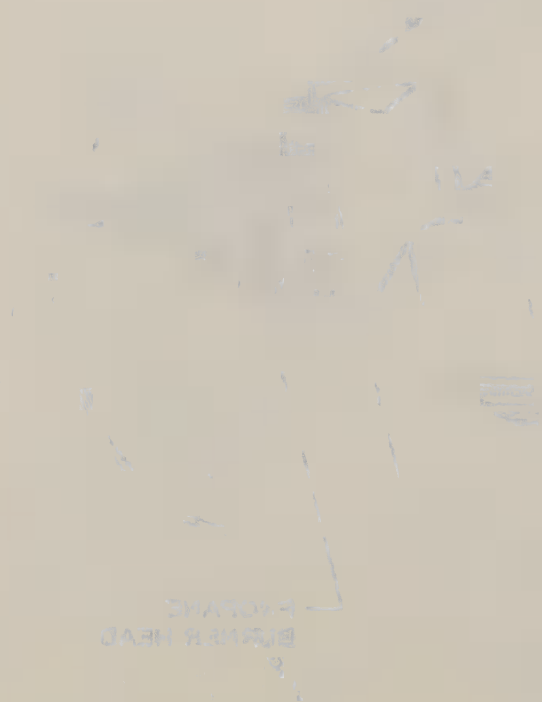


Figure 2.--Modified equipment to increase air volume, velocity, and temperature.



The following specifications apply
to the low volume-high velocity equipment:

Potts Blower	- Wisconsin 12 hp engine - Volume = 4,800 cfm - Outlet velocity = 15,400 feet per minute
Burners	- Manchester vaporizing liquid burners = 30 gallons per hour @ 125 psia each
Fuel	- Propane fuel = 91,500 BTU/gallon (high heat value)
Outlet Air Temp.	- (1) burner = 529.5° F. above inlet air temp.

2. This equipment was designed to direct a broad curtain of conditioned air down into the plant from the back of a moving vehicle and thus treat a wide strip (fig. 3). This equipment was identified as high volume-low velocity.

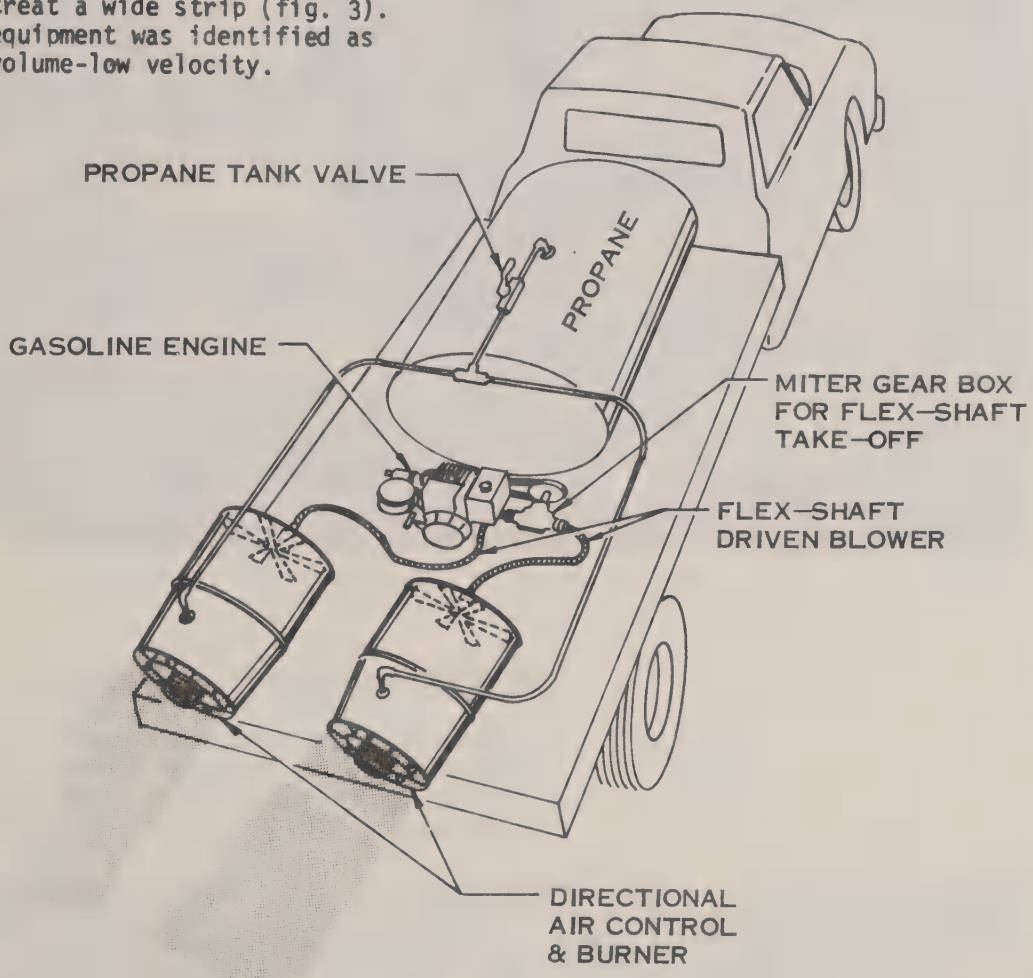


Figure 3.--Equipment designed to treat a wide strip.

The following specifications apply to the high volume-low velocity equipment:

Engine	- 8 hp Wisconsin
Blowers	- (2) 24-inch Dayton spray booth fans - Volume = 10,000 cfm each @ 2,000 rpm - Velocity (nozzle) = 5,663 feet per minute
Burners	- (4) Manchester vaporizing liquid burners = 30 gallons/hr each @ 125 psia
Fuel	- Propane, 91,500 BTU/gallon (high heat value)
Outlet Air Temp.	- 508° F. above inlet air temp.

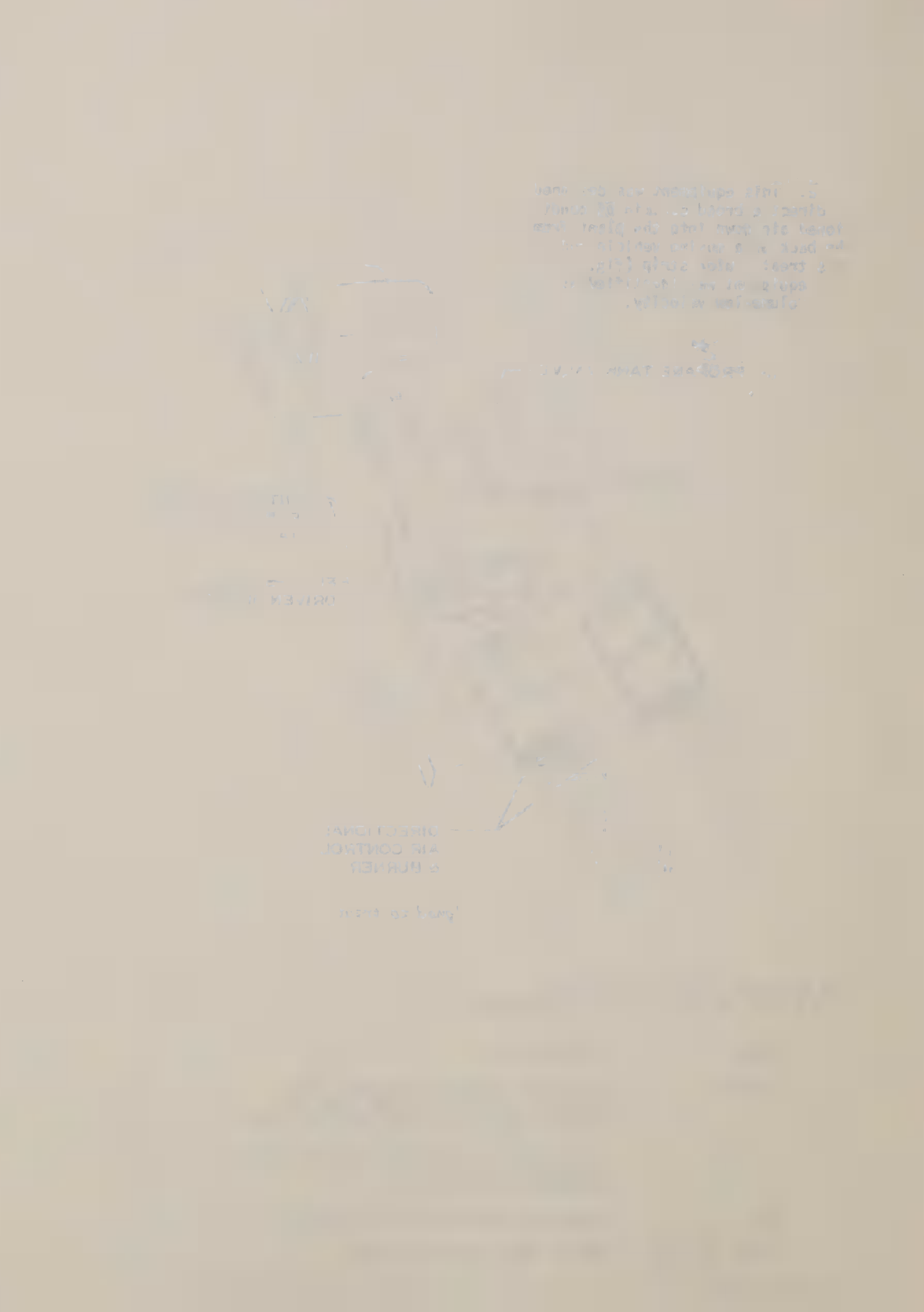


Figure 4.--Field testing of low volume-high velocity equipment.

Field Evaluations of Prototype Equipment

Field tests were conducted on selected plots near Lake Creek, Ketchum District, Sawtooth National Forest in May 1972 of the two prototypes (figs. 4 and 5).

Figure 5.--Field testing of high volume-low velocity equipment.

High Volume-Low Velocity Equipment

A 1-acre square plot was staked at the corners and the area treated. The time required to treat the acre and the plant reaction to treatment were recorded as follows:

- The acre was treated by starting at a corner, driving around the perimeter and proceeding to the center of the plot in this manner (fig. 6).
- Time required to treat 1 acre was 45 minutes.
- Treatment width was 10-11 feet, with an estimated mortality of 90 percent within the strip.
- Plant reaction was an almost immediate loss of natural coloration of the leaf, changing from a natural light green to a silvery tint, making the swaths easily recognizable for alignment of the equipment.

Due to limitations of the vehicle's turning radius, overlapping at the ends of the plot occurred. This resulted in overtreatment of the plants at these ends. A 90 percent reduction in sagebrush was experienced on this plot (see Site Analysis Studies).

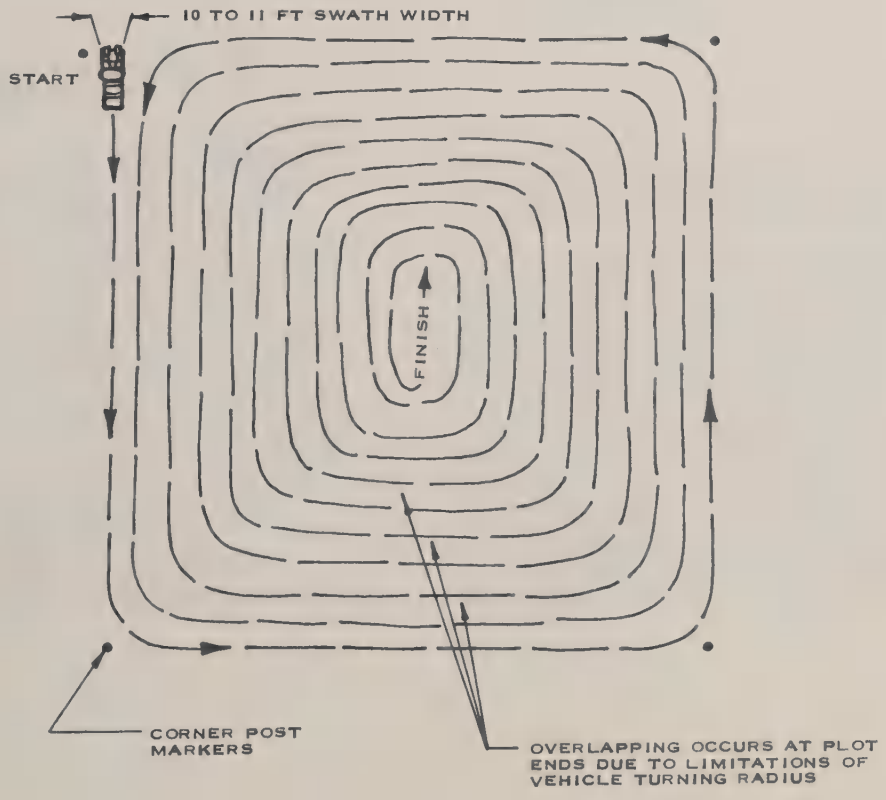


Figure 6.--Method of treating a 1-acre square plot.

Low Volume-High Velocity Equipment

A plot was selected that was long and narrow due to land restrictions for this evaluation. The data recorded were time for treatment and the plant reaction to treatment, as follows:

> The plot was treated by starting at a corner and driving to one end, turning and proceeding back to the other end (fig. 7).
>
> Because of spotty treatment (untreated and partially treated plants) within the swath width, this equipment was not evaluated any further and was considered less effective in treatment than the high volume-low velocity equipment.

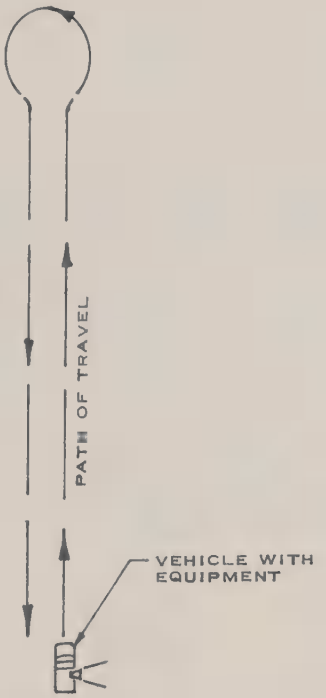


Figure 7.--Method of treating a long, narrow plot.

Results of Field Evaluations of Prototype Equipment

The results of field tests conducted using the two methods and equipment proved that (1) directing a broad high-volume curtain of high temperature air downward into the foliage is a more effective method for treating the foliage of a greater number of plants to the high temperature environment than by directing a narrow low-volume stream of high temperature air angularly across the foliage; and (2) equipment developing a broad curtain of high-volume, high temperature air is a practical transportable means of creating an instantaneous death-inducing environment surrounding the plant's foliage.

Operational Evaluations of High Volume-Low Velocity Prototype Equipment

These evaluations were conducted for the purpose of determing fuel consumption and treatment rates for the high volume-low velocity equipment. Three sites were selected for treatment in the Ketchum Ranger District on the Sawtooth National Forest: (1) A rectangular plot of approximately 16 acres on Hyndman Creek of the East Fork Wood River drainage. (2) Two irregular plots approximately 5 acres each in Cove Creek on the East Fork Wood River Drainage.

Results of the tests are tabulated below:

Date	Time of Day*	Location	Acreage treated	Time Hr.	Time Min.	Fuel used (gal.)	Swath method	Ground slope (estimated)	Moisture on plant	Percent sage kill (est.)	Treatment rate acres/hr.	Fuel consumption rate gal/acre
10/17	a.m.	Hyndman Cr.	2.0	1	00	61	Peripheral	30%	Frost	80%	2.0	30.5
10/17	p.m.	Hyndman Cr.	4.5	2	00	107	Parallel	0-30%	None	90%	2.5	21.4
10/18	a.m.	Hyndman Cr.	4.5	3	00	239	Parallel	0-30%	Frost	90%	1.7	48.0
10/18	p.m.	Hyndman Cr.	4.5	2	00	167	Parallel	15-30%	None	90%	2.5	33.4
10/19	a.m.	Cove Creek	5+	1	45	( ) (260)	Peripheral	0-15%	None	No est.	2.8+	) 26.0)
10/19	p.m.	Cove Creek	5+	1	30	( )	Peripheral	0-15%	Rain	No est.	3.3+	)
											2.5 (ave.)	26.0 (ave.)

* No attempt was made to determine amount of acreage treated per day.

CONCLUSIONS AND COMMENTS

These operational tests indicated that for the fixed conditions of fuel flow rates, blower speeds and equipment position, as provided by the prototype equipment, the cost of operation was a direct function of treatment rates. The limitations imposed by the terrain on the mobility of the 1-ton, 2-wheel drive truck indicate the variation in treatment rates (from 1.7 to 3.3 acres per hour). Fuel consumption for the individual plots was determined by fuel tank gage readings and cannot be considered as reliable or accurate. Total fuel consumed for the total acreage treated was determined from the total fuel purchased for the tests less the difference of the amount of the initial fuel in the tank prior to filling and the remaining fuel after the test.

The effectiveness of treatment (percent of kill) was that amount of kill estimated the day following treatment and was made from observation only. Where a return to the site was not made, no estimate of kill is given, as in the case of the Cove Creek 5-acre sites.

Grass, Forbs, and Browse Production Studies

A site analysis study was conducted by Ketchum Ranger District personnel both on the untreated and thermally treated plots in Lake Creek. The production study was made September 1972, approximately 5 months after treatment. Both plots had been grazed by sheep during the summer. Attached copies of study show the results of the analysis. While the untreated plot yielded a total dry weight of 738 pounds, or 8.4 percent more than the treated plot, the treated plot yielded 38.3 percent more grass and forbs. The untreated plot supported 260 pounds dry weight of sagebrush, while the treated plot had only 20 pounds. The enclosures give further information.

Lake Creek Thermal Sagebrush Treatment

WRITEUP NO.

SITE ANALYSIS

PHOTO NO.

FOREST	RANGER DISTRICT	ALLOTMENT	EXAMINER	DATE
Sawtooth	Ketchum	Lake Creek	Baldwin	9/21/72

TRANSECT NO.	PLOT SIZE	PLOT INTERVAL	TYPE DESIGNATION	KIND OF LIVESTOCK	SLOPE	ASPECT
1	.96	1 chain			2%	SW

LOCATION Transect is immediately adjacent to the north side of the burn plot and runs from west to east.

ELEVATION

	SPECIES	PLOTS 1	2	3	4	5	6	7	8	9	10	TOTAL PROD.	GRAMS USED	% UTIL.	DRY WT. PROD.	PCT. COMPOSITION	DESIRABILITY RATING
GRASSES	FEID	4	2	4	2	3	4	4	3	3	3	32	12	38	220	30	
	STCO2			2								2	0	0	10	1	
	AGSPI	1		2	1	1	1	2	2			10	3	30	70	10	
	STLE		4									4	1	25	32	4	
	KOCR				2			2				4	2	50	28	4 *	
												Total Grass Prop.			360		
FORBS	HIAL					1	1					2	1	50	12	2	
	PODOD					1			1			2	0		10	1	
	LUPIN							2		1		3	2	66	90	12	
	ERIOG									1		1	0		6	1	
												Total Forb Prod.			118		
BROWSE	ARTRT	6	5	2		5		6	12	6	10	52	0		260	35	
												Total B.W / acre = Production			738	pounds	
100%	% OVERSTORY (TREES)																
	% OVERSTORY (SHRUB)																
	% CROWN COVER (HERB)																
	% BARE GROUND	20	10		30	20	20	20	40	40	20	220					
	% ROCK & PAV(NAT.)	10	10		20	10		10	10	20	10	100					
	% ROCK & PAV(UNNAT.)																
	% VEG. & LITTER	70	80	100	50	70	80	70	50	40	70	680					
	% SOIL DISTURBANCE																
	DROPPINGS																
	PELLET GROUPS																

% DESIRABLE _____

% INTERMEDIATE _____

% LEAST DESIRABLE _____

CONDITION RATING:

COMPOSITION RATING _____

PRODUCTION RATING _____

FORAGE CONDITION RATING _____

GROUND COVER INDEX _____

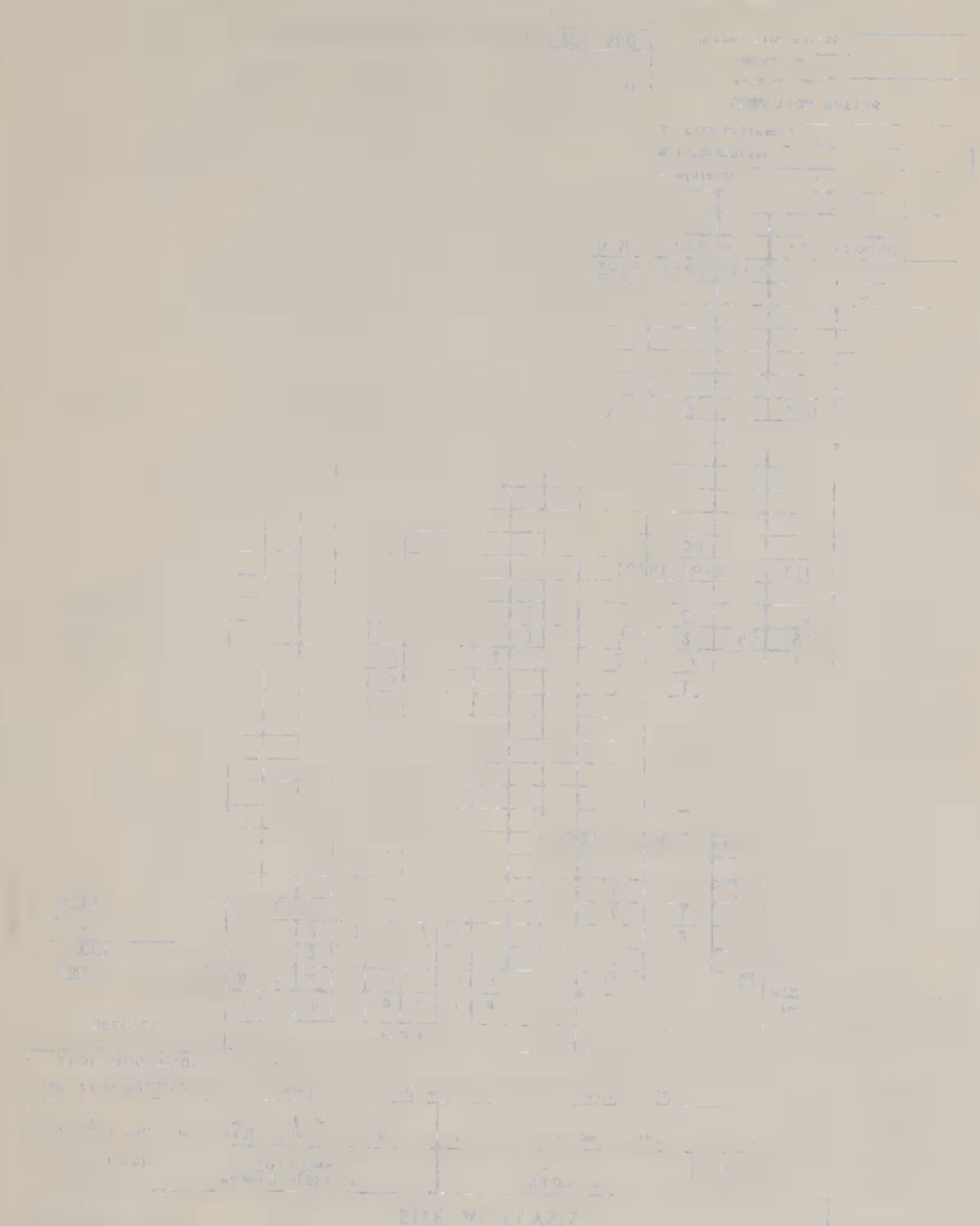
CURRENT EROSION INDEX _____

SOIL CONDITION RATING

* 9.6 SQ. FT. PLOT COMES OUT DIRECTLY IN POUNDS PER ACRE WHEN TEN PLOTS ARE TOTALED. ADD A CIPHER (0) TO TOTALS IF 0.96 SQ. FT. PLOT IS USED.

BROWSE: CONDITION _____ APPARENT TREND _____

FORM R4-2200-13 (5/64)



WRITEUP NO.

SITE ANALYSIS

PHOTO NO.

FOREST	RANGER DISTRICT	ALLOTMENT	EXAMINER	DATE
Sawtooth	Ketchum	Lake	Baldwin	9/21/72

TRANSECT NO.	PLOT SIZE	PLOT INTERVAL	TYPE DESIGNATION	KIND OF LIVESTOCK	SLOPE	ASPECT
1	.96	1 chain		sheep	2%	SW

LOCATION Transect is located in bottom of Lake Creek and runs diagonally from the S.W. corner to the N.E. corner of burn plot

ELEVATION 6200

	SPECIES	PLOTS 1	2	3	4	5	6	7	8	9	10	TOTAL PROD.	GRAMS USED	% UTIL.	DRY WT. PROD.	PCT. COMPOSITION	DESIRABILITY RATING
GRASSES	$STCO_2$		1		4					2		7	4	57	56	8	
	STLE			1				4	2	4	2	13	3	23	104	15	
	JUBA	2	2		2							6	1	16	30	5	
	KOCR						2		2		1	5	2	40	35	5	
	AGSPI	4	1			1		2				8	5	62	56	8	
	FEID	3	4	6	4	4	3	4	3	4	5	40	22	55	280	41	
												Total Grasses			561		
FORBS	ANRO			1								1	0		4	1	
	LUPIN					10	2		4			16	10	62	96	14	
												Total Forbs			100		
BROWSE	ARTRT										4	4			20	3	
												Total D.W. Production per ac. =			681	pounds	
100%	% OVERSTORY (TREES)																
	% OVERSTORY (SHRUB)																
	% CROWN COVER (HERB)																
	% BARE GROUND	10		10		10	20	20	20	30	20	140					
	% ROCK & PAV(NAT.)	10		10		20	10	10	10	10	10	90					
	% ROCK & PAV(UNNAT.)																
	% VEG. & LITTER	80	100	80	100	70	70	70	70	60	70	770					
	% SOIL DISTURBANCE																
	DROPPINGS																
	PELLET GROUPS																

% DESIRABLE _____

% INTERMEDIATE _____

% LEAST DESIRABLE _____

CONDITION RATING:

COMPOSITION RATING _____

PRODUCTION RATING _____

FORAGE CONDITION RATING _____

GROUND COVER INDEX _____

CURRENT EROSION INDEX _____

SOIL CONDITION RATING _____

* 9.6 SQ. FT. PLOT COMES OUT DIRECTLY IN POUNDS PER ACRE WHEN TEN PLOTS ARE TOTALED. ADD A CIPHER (0) TO TOTALS IF 0.96 SQ. FT. PLOT IS USED.

BROWSE: CONDITION _____ APPARENT TREND _____

FORM R4-2200-13 (5/64)

NEW EQUIPMENT DEVELOPMENT

Design and fabrication of an improved version of the high volume-low velocity equipment was undertaken in FY 1973 (figs. 8 and 9).

Specifications are as follows:

Fan Drives	- (2) hydraulic belt drive motors, 20 GPM max. @ 1,000 psi
Fans	- (4) Dayton 27-inch duct fans
CFM	- 38,000 to 50,000 cfm
Outlet Velocity	- 3,057 to 3,980 fpm
Burners	- (8) Manchester, self vaporizing
Outlet Air Temp.	- 38,000 cfm @ 120 gal/hr - 268° F. - 38,000 cfm @ 240 gal/hr - 536° F. - 50,000 cfm @ 240 gal/hr - 406° F.
Fuel	- Propane
Fuel Consumption	- 120 to 240 gal/hr @ 120 psi fuel pressure
Fuel Control	- Manual with automatic constant ignition
Projected treatment width	- 20 to 22 feet
Treatment cover	- 7.5 acres/hr @ 3 mph
Hydraulic elevation & tilt control air-burner	
Flexibility	- boom may be mounted on a tractor with demountable front end loader or dozer blade, or may be installed on rubber-tired skidder. The air burner boom assembly requires a hydraulic oil supply of 20 GPM @ 1,000 psi max. for the fan drive hydraulic motors. Provisions for the fuel tank mounting must be made on an individual basis for the particular vehicle used.

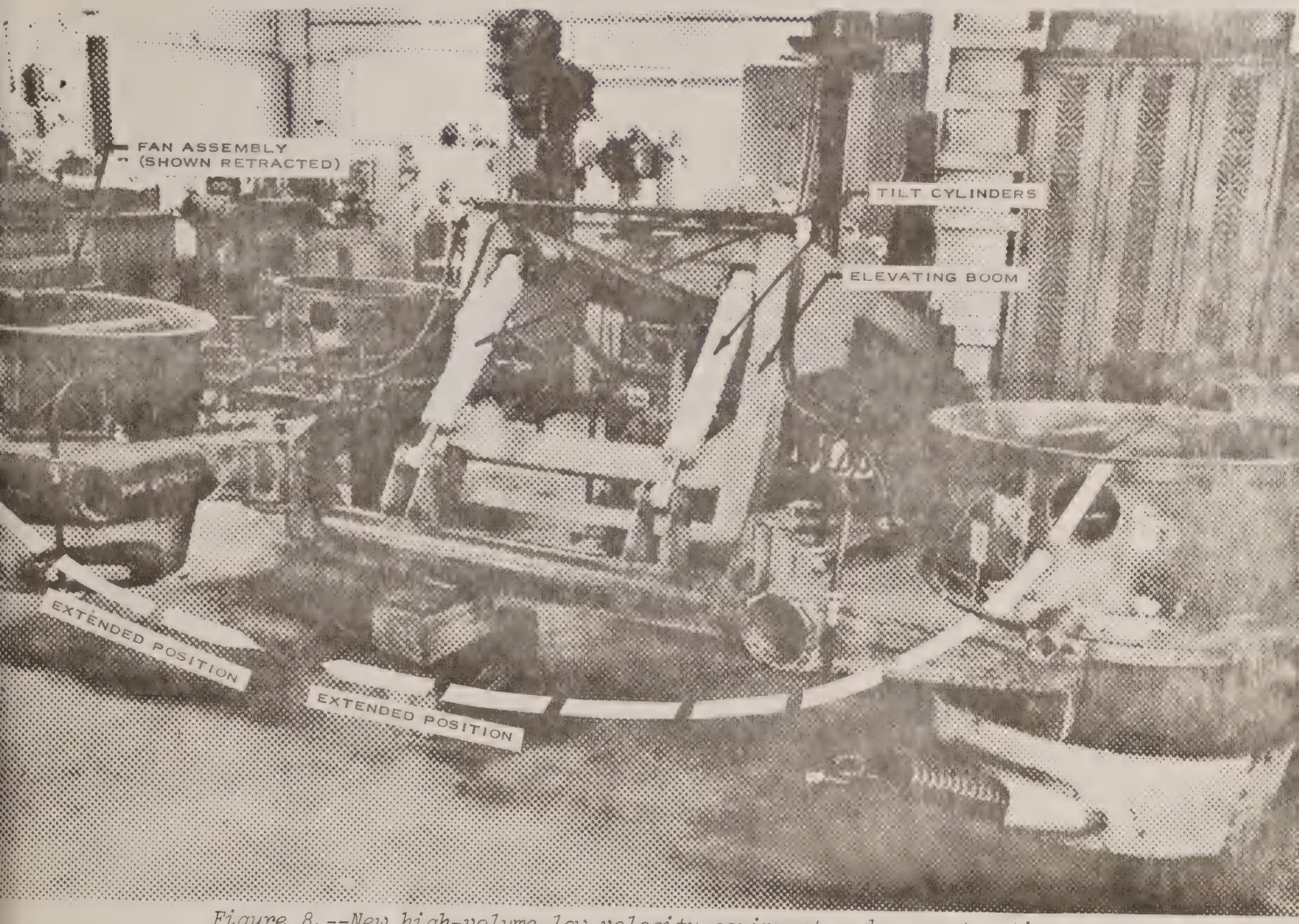


Figure 8.--New high-volume-low velocity equipment under construction.

Figure 9.--Side view of equipment under construction.

RECOMMENDATIONS

A. The improved version of the basic prototype equipment requires evaluation to determine: (1) operating qualities of the equipment, such as elevating and tilt positions, fuel control and air volume for optimum temperatures and effective treatment and (2) production rates and operating costs. Minor modifications and improvements, where necessary to improve the operational qualities, can be anticipated from these tests.

B. Field studies to determine the effect of this method of control on other species of rangeland invaders have been requested. In order to accomplish this, improvements in the high volume-low velocity prototype equipment to make it more flexible for treatment of different species are necessary and recommended.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